GASKET RESOURCES INC.

DURLON® GASKET MATERIAL

TECHNICAL HANDBOOK

& FLUID SEALING PROGRAM

June 2004

GASKET RESOURCES INC.

DURLON® GASKETING TECHNICAL HANDBOOK

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DURLON® Products are Manufactured to ISO 9001:2000 Quality Standards

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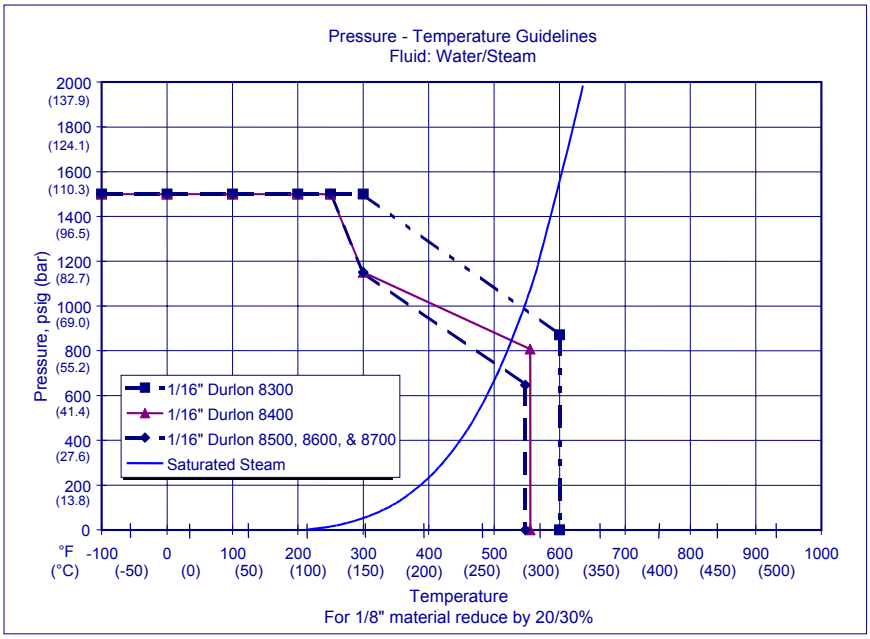
Style	Composition	Description
8300	Carbon/NBR	A premium grade compressed sheet, DURLON 8300 is excellent in steam and hydrocarbon services in the refining, petrochemical and power generation industries. Other applicatons include oil, water, mild alkalis, mild acids, and solvents. DURLON 8300 contains high strength carbon fibers bonded with nitrile (NBR) synthetic rubber.
8400	Phenolic/NBR	With an extremely wide pH application range, DURLON 8400 can be used in process piping and equipment in chemical, pulp and paper, and other general industrial applications. * US Patent No. 5098777
8500	Aramid-Inorganic/NBR	Our workhorse material, DURLON 8500 is excellent in steam, natural gas, soybean processing and with new generation refrigerants. A high quality general service gasket material for use in a wide range of services in pulp and paper, food, beverage, pharmaceutical, chemical, refinery, gas pipeline and general industry. FIRE TESTED: DURLON 8500 passed a modified API 607 fire test.
8600	Aramid-Inorganic/SBR	A high quality gasket material containing high strength aramid and inorganic fibers bonded with SBR rubber. An excellent choice for steam or services where a white gasket material is required.
8700	Aramid-Inorganic/CR	A high performance compressed gasket material for use in processes that require a neoprene (CR) bonded sheet. Excellent for steam, oils and refrigeration services.
7900/7950	Aramid/NBR	An economy grade general service compressed sheet with NBR rubber binder for mild service in piping and equipment and OEM applications in steam, hydrocarbons and refrigerants. An economical alternative when service ranges and applications are not severe.

Anti-Stick Properties: Much effort has gone into improving the anti-stick release agents of all compressed DURLON® products. All DURLON® compressed gasket materials have passed the MIL-G-24696B Navy Adhesion Test (366°F/48 hrs).

PxT Chart - **DUR**LON® Compressed Gasket Materials



Note: Consult your representative for applications above Class 300

Typical Physical Properties

DURLON® **Style**	**8300**	**8400**	**8500**	**8600**	**8700**	**7900/7950**
Color:	Black	Gold	Green	White	Blue	7900 - Off-White 7950 - Blue
Fluid Services:	Saturated Steam, Oils, Dilute Acids & Alkalis, Solvents Hydrocarbons	Steam, Oils, Fuels, Solvents, Caustics, Refrigerants, Dilute Acids & Alkalis	Saturated Steam, Oils, Dilute Acids & Alkalis, Solvents, Fuels, Refrigerants	Saturated Steam, Water, Dilute Acids & Alkalis, Inert Gases, Ammonia	Saturated Steam, Oils, Water, Dilute Acids & Alkalis, Refrigerants	Steam, Water, Inert Gases, Oils, Fuels, Dilute Acids & Alkalis
Fiber System:	Carbon	Phenolic	Aramid/Inorganic	Aramid/Inorganic	Aramid/Inorganic	Aramid
Binder:	NBR	NBR	NBR	SBR	CR	NBR
Density, g/cc (lbs/cu. ft):	1.6 (100)	1.7 (106)	1.7 (106)	1.7 (106)	1.7 (106)	1.7 (106)
Temperature, Range: Continuous, max:	-100 to 800ºF (-73 to 427ºC) 600ºF (315ºC)	-100 to 800ºF (-73 to 427ºC) 554ºF (290ºC)	-100 to 700°F (-73 to 371°C) 548ºF (287ºC)	-100 to 700°F (-73 to 371°C) 548ºF (287ºC)	-100 to 700°F (-73 to 371°C) 548ºF (287ºC)	-100 to 700ºF (-73 to 371ºC) 400ºF (204ºC)
Pressure Max:	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1000 psig (70 bar)
ASTM F36, Compressibility	8-16%	8-16%	8-16%	8-16%	8-16%	7-17%
ASTM F36, Recovery	50%	50%	50%	45%	45%	40%
ASTM F38, Creep Relaxation	18%	25%	20%	20%	20%	20%
ASTM F152, Tensile Strength across grain, psi (MPa)	1,800 (12.4)	1,800 (12.4)	2,000 (13.8)	1,800 (12.4)	1,500 (10.3)	1,600 (11.0)
Fluid Resistance, pH Range (room temperature) ASTM F146	3 to 11	2 to 13	3 to 11	3 to 11	3 to 11	3 to 11
IRM 903 Oil 5h/300°F(149°C) Thickness Increase Weight Increase	0 to 10% 10%	0 to 15% 15%	0 to 15% 15%	15 to30% 30%	0 to 15% 15%	0 to 15% 15%
ASTM Fuel B 5h/70°F (21°C) Thickness Increase Weight Increase	0 to 10% 12% Max	0 to 10% 15% Max	0 to 10% 10% Max	5 to20% 30% Max	0 to 15% 15% Max	0 to 10% 12% Max
Leachable Halides:	500 ppm max.	1000 ppm max.	1000 ppm max.	-	-	-
Leachable Chlorides:	200 ppm max.	400 ppm max.	100 ppm max.	-	-	-
Leakage: DIN 3535	0.05 cc/min	0.03 cc/min	0.03 cc/min	0.05 cc/min	0.05 cc/min	0.05 cc/min
Volume Resistivity, ASTM D257, 1/16"	5 x 10^9 ohm-cm	3.1 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	-
Dielectric Breakdown, ASTM D149, 1/16"	0.04 kv/mm	14.6 kv/mm	11.7 kv/mm	11.7 kv/mm	11.7 kv/mm	11.0 kv/mm
Gasket Factors: Gb psi (MPa) a Gs psi (MPa)	1/16" 1/8" 512 (3.5) 1716 (11.8) 0.36 0.21 0.13 (0.0) 0.7(0.01)	1/16" 1/8" 2000 (13.8) – 0.194 – 340 (2.3) –	1/16" 1/8" 650 (4.5) 400 (2.8) 0.33 0.35 200 (1.4) 20 (0.14)	– – –	– – –	– – –
ASTM F147, Flexibility	10x	8x	10x	8x	8x	10x
ASTM F104 Line Call-Out	F712120-B3E22M5	F712120-B4E22M5	F712120-B3E12M6	F712440-B3E24M5	F712330-B5E45M5	F712120-B3E22M5

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

In General GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Thermoseal**	**Flexitallic**
Durlon 7900/7950	2550, 2900, Blue-Gard® 3000	Klinger®sil C-4201, C-4324, C-4401, 4300	SF1600, AF 2100, AF-2400
Durlon 8300	HTC-9800, HTC-9850, G-9900, ST-706	Klinger®sil C-4500	SF 5000
Durlon 8400	Blue-Gard® 3700, IFG 5500	Klinger®sil C-7400	–
Durlon 8500	Blue-Gard® 3000, IFG® 5500	Klinger®sil C-4401, C-4430, & C-4433	SF 3300, SF 3500
Durlon 8600	Blue-Gard® 3200, 3400	Klinger®sil C-6400	SF 2420
Durlon 8700	Blue-Gard® 3300	Klinger®sil C-5400	SF 2440

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

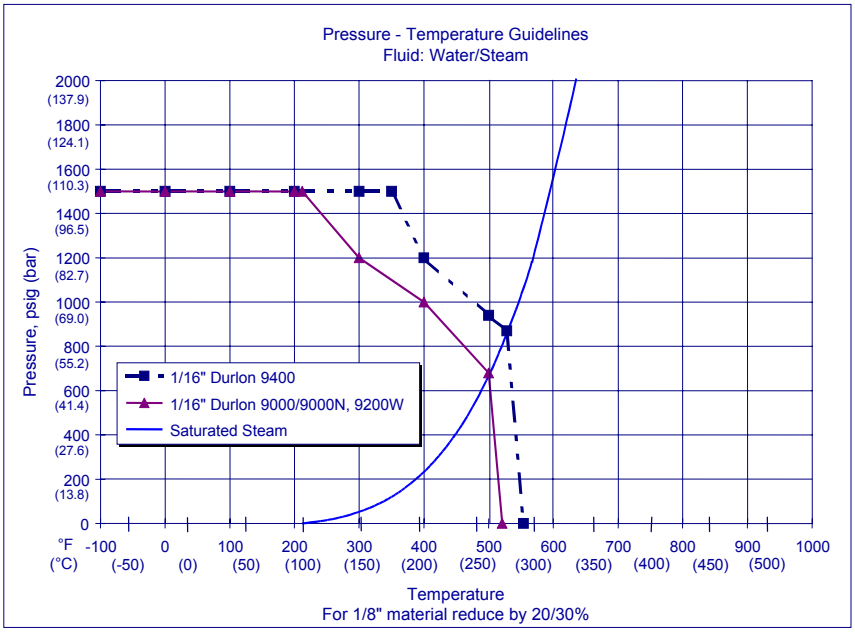
Warning: These materials should never be recommended when both temperature and pressure are at the maximum listed. Properties and applications shown are typical. No application should be undertaken by anyone without independent study and evaluation for suitability. Never use more than one gasket in one flange joint, and never reuse a gasket. Improper use or gasket selection could cause property damage and/or serious personal injury. Data reported in this brochure is a compilation of field testing, field service reports and/or in-house testing. While the utmost care has gone into publishing the information contained herein, we assume no responsibility for errors. Specifications and information contained in this brochure are subject to change without notice. This edition cancels and obsoletes all previous editions.

Style	Composition	Description
9000/9000N	Pure PTFE resins with inorganic fillers	DURLON 9000/9000N is used extensively in chemical, pulp and paper, food and beverage and the railroad tankcar industries. It has been tested and approved for liquid chlorine, caustics, liquid oxygen, and high purity applications in the pharmaceutical industry (9000N, blood components manufacturing). The fillers in DURLON 9000/9000N are engineered shapes, homogeneously blended with pure PTFE resins that do not wick.
9200W	Pure PTFE resins with barium sulfate filler	Suitable for use in aggressive chemicals. Including caustics, hydrogen peroxide, sodium hypochlorite, nitric acid, liquors and digester in pulp and paper service. Applications In the chemical, pharmaceutical and plastics industries include butadiene, hydrofluoric acid, vinyl chloride, methyl methacrylates, and styrene. DURLON 9200W is also used extensively in railroad tankcar applications.
9400	Pure PTFE resins with carbon filler	Carbon filled PTFE is approved as a material of construction for anhydrous hydrogen fluoride (AHF). DURLON 9400 also demonstrates good electrical conducting properties.
9600	Expanded PTFE	DURLON 9600 is an EXPANDED PTFE gasket material made with only pure PTFE resins. It is suitable for use in steel flanges and flanges with irregular surfaces.

Independent testing has shown the fillers in the DURLON method to be more homogeneously blended than calendered, or layered filled PTFE gasket materials, giving DURLON filled PTFE's more consistent physical and mechanical properties without voids, separation and chemical compatibility problems found in the layered construction method.

Fabrication Services. DURLON Filled PTFE is available in LATHE CUT, STEP GASKETS and factory WELDED for diameters over 60".

PxT Chart - **DUR**LON® PTFE Gasket Materials



Note: Consult your representative for applications above Class 300

Typical Physical Properties

DURLON® Style	9000/9000N	9200W	9400	9600
Color:	9000 - Blue 9000N- White	Granite White	Black	White
Fluid Services:	Steam, Oils, TiO2, ClO2, Liquid Chlorine[1], Acids, Caustics, H2O2, Liquid Oxygen[2], Oleum	Steam, Nitric Acid, TiO2, ClO2, H2O2, Liquors, Sulfur Dioxide, Brown Stock, Phosphoric Acid	Acids, Aqueous and Anhydrous Hydrogen Fluoride, Steam, Fuels, Oils, Alcohols	Aqueous and Anhydrous Hydrogen Fluoride, Steam, Oils, Caustics, Acids, Alcohols
Filler System:	Inorganic	Barium Sulfate	Carbon	—
Resin System:	Pure PTFE	Pure PTFE	Pure PTFE	Pure Expanded PTFE
Temperature, Range: Continuous, max:	-350 to 520°F (-212 to 271°C) 500ºF (260ºC)	-350 to 520°F (-212 to 271°C) 500ºF (260ºC)	-350 to 550°F (-212 to 288°C) 500ºF (260ºC)	-350 to 600°F (-212 to 316°C) 500ºF (260ºC)
Pressure Max:	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1800 psig (124 bar)
Density, g/cc (lbs/cu. ft):	2.2 (138)	2.5 (156)	2.1 (135)	0.8 (49.9)
ASTM F36, Compressibility	8-16%	8-16%	5-12%	40-60%
ASTM F36, Recovery	40%	35%	40%	12%
ASTM F38, Creep Relaxation	30%	30%	30%	30%
ASTM F152, Tensile Strength across grain, psi (MPa)	2,000 (13.8)	1920 (13.2)	2100 (14.5)	—
Fluid Resistance, pH Range (room temperature)	0 to 14	0 to 14	0 to 14	0 to 14
Leakage: DIN 3535	0.01 cc/min	0.01 cc/min	0.01 cc/min	0.01 cc/min
Leakage: TA-Luft (VDI 2440) 1 bar (14.5 psig) @ 180°C (392°F)	7.55 x 10^{-6} mbar·l/(m·s)	1.89 x 10^{-5} mbar·l/(m·s)	-	-
Volume Resistivity, 1/16"	1.0 x 10^{5} ohm-cm (ASTM D257)	—	61 ohm-cm (ASTM D991)	—
Dielectric Breakdown, ASTM D149, 1/16"	16 kv/mm (406 V/mil)	—	1 kv/mm (33 V/mil)	—
Gasket Factors Gb psi (MPa) a Gs psi (MPa)	1/16" 1/8" 639 (4.4) 495 (3.41) 0.22 0.262 55 (0.38) 65 (1.45)	1/16" 1/8" 153 (1.05) 96 (0.66) 0.36 0.437 15 (0.1) 14 (0.1)	1/16" 1/8" 1701 (11.7) 1412 (9.7) 0.173 0.164 99 (0.68) 248 (1.7)	1/16" 1/8" 1200 (8.3) 1400 (9.65) 0.2 0.2 3.5 (.024) 1.5 (0.01)
ASTM F104 Line Call-Out:	F452111-A9B5E11K6M6	F452111-A9B5E11K6M5	F452111-A9B5E11K6M6	F428111-A9B5
Notes:	1. Pamphlet 95, The Chlorine Institute 2. O2 Certified - BAM 3. Conforms to FDA	1. O2 Certified - BAM 2. Conforms to FDA	—	Conforms to FDA

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Flexitallic**	**Thermoseal**
Durlon 9000/9000N	Gylon 3500, 3504[2], 3510[3]	Sigma 500, 511[2], 533[3]	TopChem 2000, 2003, 2005, 2006[3]
Durlon 9200W	Gylon 3510	Sigma 533	TopChem 2003
Durlon 9400	Gylon 3530	**W.L. Gore**	**Intertech®**
Durlon 9600	Gylon 3540, 3545	Gore-Tex® GR	SQ-S

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.
[2] Check torque for non-metallic flanges. [3] Exception, hydrofluoric acid.

Warning: These materials should never be recommended when both temperature and pressure are at the maximum listed. Properties and applications shown are typical. No application should be undertaken by anyone without independent study and evaluation for suitability. Never use more than one gasket in one flange joint, and never reuse a gasket. Improper use or gasket selection could cause property damage and/or serious personal injury. Data reported in this brochure is a compilation of field testing, field service reports and/or in-house testing. While the utmost care has gone into publishing the information contained herein, we assume no responsibility for errors. Specifications and information contained in this brochure are subject to change without notice. This edition cancels and obsoletes all previous editions.

Corrugated Flexible Graphite

Style	Composition	Description
CFG	Flexible Graphite / Corrugated Stainless 316 Core	Designed for severe service conditions, the proprietary design of the corrugations gives **CFG** its superior sealing and recovery characteristics for tough conditions in the refining, chemical, petrochemical and pulp and paper industries. **CFG** is suitable for service in steam, oil, water, mild alkalis, hydrocarbons mild acids, and solvents.

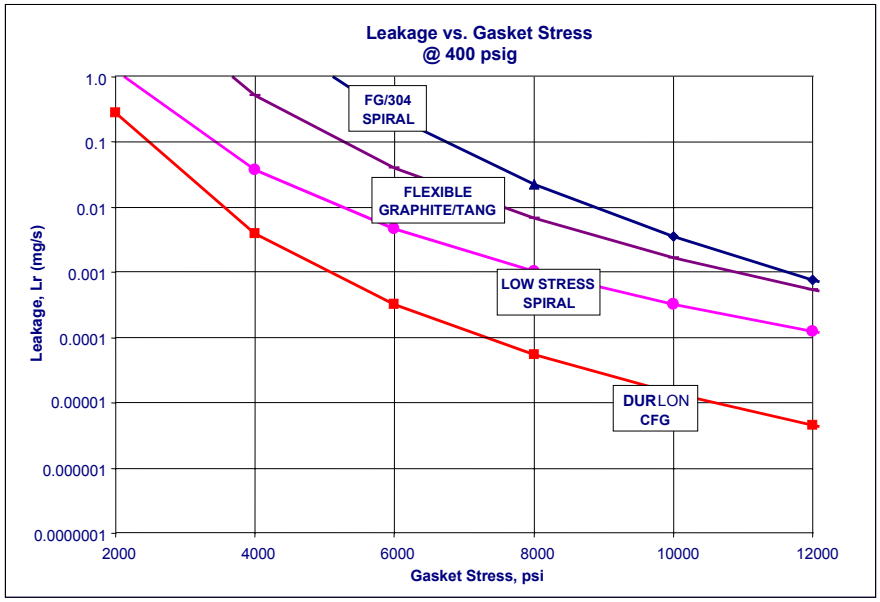
DURLON CFG will maintain a tigh seal in a wide range of initial seating stresses making it the universal replacement for spiral wound, double jacketed and traditional flexible graphite.

Sizes & Types:

- Standard ANSI Class 150 and 300 Ring and Full Face: 1/2" – 24"
- Non Standard MSS SP-44 & API 605: 26" – 96"
- Non Standard Ovals: Handhole and Manway Gaskets
- All Heat Exchanger Styles
- Different metals available to match flange metallurgy, temperature or chemical.

Advantages:

- **Fire tested/fire resistant** – Passed the modified API 607 fire test
- **Recovery/Spring Back** characteristics for excellent sealing and thermal cycling.
- **Blow Out Resistant** – Metal core counteracts internal pressure spikes.
- **Superior Emissions Control** – DIN 3535 gas permeability/leakage <0.01 cc/min
- **Easy to handle, easy to install.**
- Seals tightly with lower bolt loads vs. spiral wounds.
  - **One thickness** – 3/32" for all applications



Physical Properties:

Temperature, Min:	-328°F (-200°C)
Max, In Air:	850°F (454°C)
In Steam:	1200°F (650°C)
Pressure, Max:	3,000 psi (207 bar)
pH Range:	0-14

Gasket Factors:

Gb	557 psi (3.8 MPa)
a	0.325
Gs	2.21 psi (0.02 MPa)

Cross-Reference

In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**JM Clipper**
CFG	Graphonic	ElastaGraph™

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

Flexible Graphite Sheet

Style	Composition	Description
FGS95	Homogeneous Flexible Graphite	Standard industrial grade sheet containing no binders or resins. Used in industrial applications such as oil refineries, power plants and chemical process plants.
FGL316	Laminated 0.002" Stainless 316 Foil Core/Flexible Graphite	Standard industrial grade sheet laminated with an adhesive bond on both sides of a .002" thick 316 stainless steel foil insert. Used where high performance and handleability is important.
FGT316	Laminated 0.004" Stainless 316 Tang Core/Flexible Graphite	Standard industrial grade sheet mechanically bonded on both sides of a .004" thick 316 stainless steel metal tang core. Used where stresses and pressures are high and improved handleability is important.

Typical Properties

Carbon, % min.	95
Moisture, % max.	1
Sulfur ppm max.	1200
Leachable Chlorides, ppm max.	100
Temperature Range:	1200°F (650°C) Saturated Steam
Oxidizing:	-450 to 850°F (-260 to 454°C)
Non-oxidizing	-450 to 5,432°F (-260 to 3,000°C)
Pressure Max:	3,000 psig (207 bar)
Fluid Resistance - pH Range:	0 to 14 at room temperature (except strong oxidizers)

Test Method	Physical Properties	FGS95	FGL316	FGT316
ASTM F36	Compressibility, % Recovery, %	35-40 20	35-40 18	30-35 20
ASTM F38	Creep Relaxation, %	5	5	5
ASTM F495	Ignition Loss, % @ 850°F (454°C) @1200°F (650°C)	 1 8	 1 6	 1 6
DIN 3535 Part 4	Gas Permeability, cc/min.	0.40	0.40	0.80
ASTM	Specifications:	F104: F517000B1M3	F868: 9FMF2	F868: 9FMF1

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

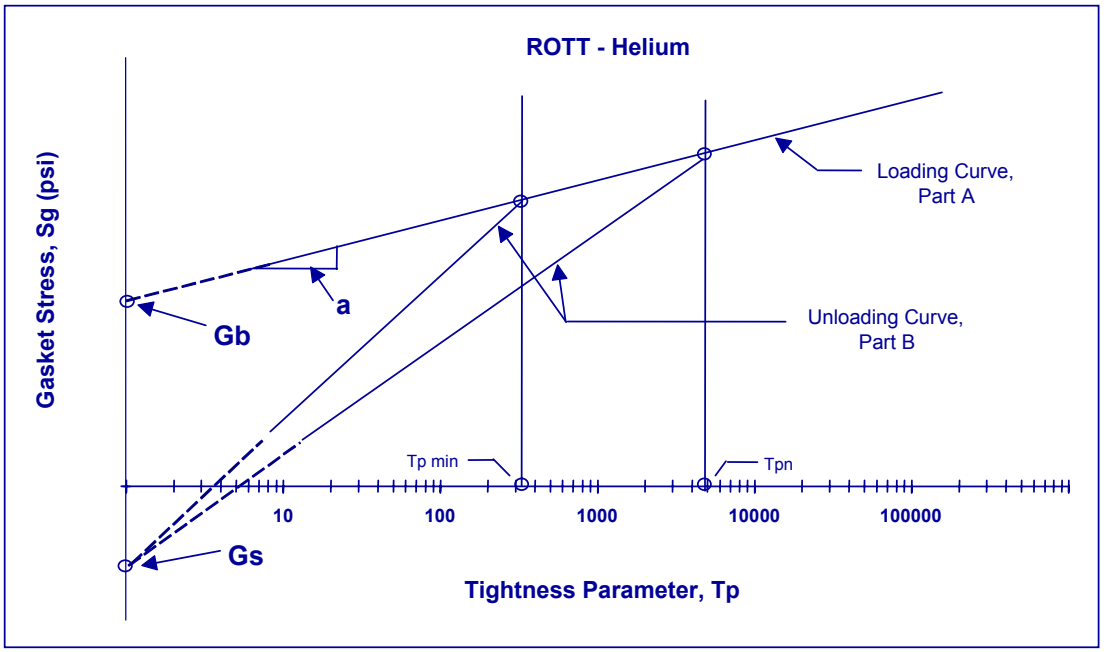
In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Flexitallic**	**Thermoseal**	**Graphoil**
FGS95	Graph-Lock 3123	Flexicarb LS	HL	GT™B
FGL316	Graph-Lock 3125SS	Flexicarb SR	SLS	GH™R
FGT316	Graph-Lock 3125TC	Flexicarb ST	PSM	GH™E

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

Proposed ASME Gasket Factors: Gb, a and Gs

New gasket factors to replace the ASME Code *m* and *y* are currently being developed by the Pressure Vessel Research Council (PVRC) and ASME. The current *m* and *y* are difficult to replicate for non-asbestos gaskets and do not consider joint leakage. The new approach to bolted joint design makes the *tightness* of the joint a design parameter.



In a manner similar to the traditional ASME Code method, the design bolt load for a joint is calculated for operating and seating requirements from the new constants *Gb, a* and *Gs* and the required tightness class associated with the minimum tightness. *Gb* and *a*, gives the gasket seating load and are similar to *y* in the present Code. *Gs* is associated with the operating stress and is similar to the *m* value in the Code.

The proposed ASME constants *Gb, a,* and *Gs* give a design bolt load obtained by interpretation of leakage test data as plots of gasket stress Sg, vs. a tightness parameter, Tp. Tp is the pressure (in atmospheres) normalized to the atmospheric pressure required to cause a helium leak rate of 1 mg/sec for a 150 mm OD gasket in a joint. Since this is about the same as the OD of an NPS 4 joint, the pressure to cause a leak of 1 mg/sec of helium for that joint is its tightness. A standard test procedure, the PVRC Room Temperature Tightness Test (ROTT) has been designed to produce the constants *Gb, a* and *Gs.* Low values for *Gb, a* and *Gs* are desirable while a higher value of Tp means a tighter joint.

Pressure - Temperature Considerations

With gasketing, there is a relationship of pressure to temperature. Generally the higher the temperature the lower the allowable gasket working pressure. This is called the PT factor of the gasket (pressure times temperature). For example, if the pressure is 700 psi and the temperature is 500°F, we would need a material with a PT factor of 350,000. Some manufacturers feel this is the maximum level for safety.

With compressed asbestos products there is a common base and structure in the material which makes comparing and using PT factors easy and predictable. Non-asbestos gasketing is not as predictable. Generally we find that all non-asbestos gasket material is temperature sensitive requiring the pressure to drop more quickly as temperature rises to insure the seal is maintained. We have reviewed performance by in-house tests, controlled operating performance, and in the field. **There is no one PxT factor to use**.

Refer to the preceding charts on pages 2 and 4 for the highest operating temperature given for the application. Find the highest pressure within the safety zone. Simple multiplication of the two will give you the PT factor.

It is always assumed the flange is correct and in good condition, the fluid is not aggressive and that the ideal thickness is 1/16". These limits will be increased for 1/32" but will decrease 20% to 30% for 1/8".

Causes of Gasket Failure

- Uneven loading of flanges holding gasket in place
- Gasket load too low
- Bolt strength too low
- Torque loss
- Bolt Relaxation/Stretch (approximately 10% in first 24 hours)
- Gasket creep
- Vibration in the system
- Thermal cycling
- Water hammer
- Elastic interaction during bolt tightening
- IMPROPER GASKET INSTALLATION PRACTICES

Torque loss is inherent in any bolted joint. The combined effects of bolt relaxation, (approximately 10% during the first 24 hours after installation), gasket creep, vibration in the system, thermal expansion and elastic interaction during bolt tightening contribute to torque loss. When torque loss reaches an extreme, the internal pressure exceeds the compressive force holding the gasket in place and a leak or blow-out occurs.

A key to reducing these effects is proper gasket installation. By bringing the flanges together slowly and parallel when installing a new gasket and taking a minimum of four bolt tightening passes, following the correct bolt tightening sequence or pattern, there is a payoff in reduced maintenance costs and increased safety.

Even when the installation is ideal, where the bolt stress is uniformly applied to each bolt, and the gasket is properly compressed, problems can still arise. Inherently with time, loosening will occur due to the factors already mentioned. If other factors such as cycling, thermal upsets, or vibration are present, periodic retorquing might be necessary.

For problem areas, high temperature applications or where there is temperature cycling, or where a flange cannot be retorqued, conical spring washers have been found to be very helpful as an aid to torque retention. They act as a spring and help lessen the effects of torque loss.

Reducing Gasket Failures:

- PROPER GASKET INSTALLATION PRACTICES
- Lubricate bolts & nut facings
- Bring the flanges together slowly and parallel
    1. Multiple passes with increasing torque,
    2. Each pass following proper tightening sequence
- Use a 1/16" thick gasket through 10" flanges and 1/8" for 12" and above
    1. 1/16" has less gasket creep
- Be sure there is adequate gasket stress.
- Periodic RETORQUING
- Use the right method of bolt up for the job

    Order of efficiency from least to greatest:

    1. Wrench and cheater bar or sledge hammer
    2. Air impact gun
    3. Torque wrench
    4. Hydraulic torque wrench
    5. Hydraulic stud tensioners
- Use the installation procedure that follows, and RETORQUE!

Finally, having the torque information for the gasket material is helpful as well. Please refer to the torque data table that follows.

GASKET RESOURCES INC.

DURLON® GASKETING - BOLT TIGHTENING WORK SHEET

Location/Identification: _____ Nominal Bolt Size: _____

Gasket Contact Surface Finish on Flange: _____; Lubricant Used: _____

(Initial each step in space provided below.)

____ 1. Visually examine and clean flanges, bolts, nuts and washers. Replace components if necessary.

____ 2. **Lubricate bolts, nuts**, **AND flange surface AROUND BOLT HOLES**, or use hardened steel washers.

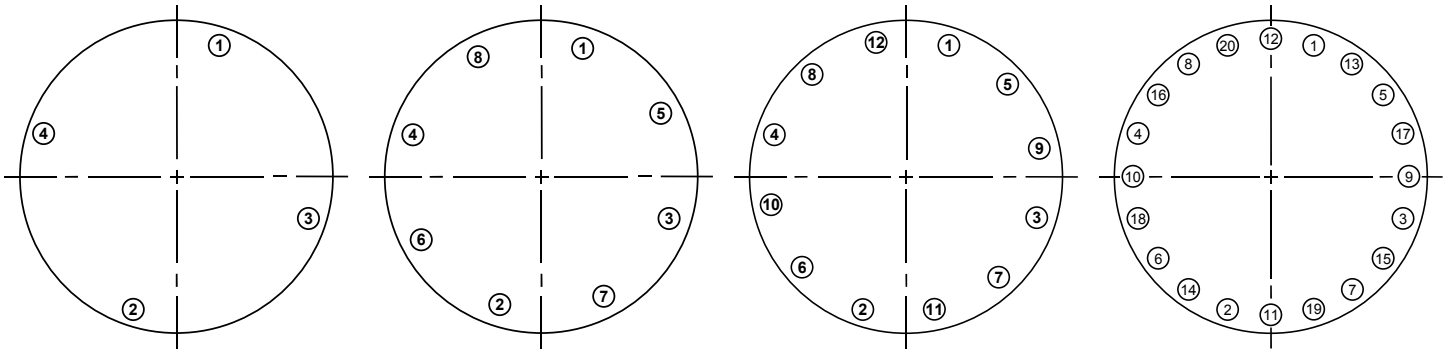
____ 3. Install new gasket. DO NOT REUSE OLD GASKET, OR USE MULTIPLE GASKETS.

____ 4. Number bolts in cross-pattern sequence according to the appropriate sketch below.

____ 5. **IMPORTANT! HAND TIGHTEN; then PRE-TIGHTEN BOLTS to 10/20 FT-LBS torque, but DO NOT EXCEED 20% of Target Torque.**

____ 6. Check gap for uniformity.

____ 7. Use the appropriate cross-pattern tightening sequence in the sketch below for Rounds 1, 2, and 3 and/or Round 4 (each sequence constitutes a "Round").



- **Final Torque:** _____ ft-lbs

___ **4-bolt and 8-bolt flanges:**

LUBRICATE, HAND TIGHTEN, PRE-TIGHTEN bolts

Round 1 - Tighten to ___ ft-lbs (30% of final torque)

Round 2 - Tighten to ___ ft-lbs (60% of final torque)

Round 3 - Tighten to ___ ft-lbs (100% of final torque)

___ **12-bolt flanges and above:**

LUBRICATE, HAND TIGHTEN, PRE-TIGHTEN bolts

Round 1 - Tighten to ___ ft-lbs. (20% of final torque)

Round 2 - Tighten to ___ ft-lbs (40% of final torque)

Round 3 - Tighten to ___ ft-lbs (80% of final torque)

Round 4 - Tighten to ___ ft-lbs (100% of final torque)

Check gap around the circumference between each of these rounds, measured at every other bolt. If the gap is not reasonably uniform around the circumference, make the appropriate adjustments by selective bolt tightening before proceeding.

___ **Rotational Round** - 100% of Final Torque (same as Round 3 or 4 above). Use ROTATIONAL, clockwise tightening sequence, starting with Bolt No. 1, for one complete round and continue until no further nut rotation occurs at 100% of the Final Torque value for any nut.

___ **Final Round** - RETORQUE after four to twenty-four hours. A large percentage of the short-term bolt preload loss occurs within twenty-four hours after initial tightening with most occurring after four to five hours. This Round recovers this loss. This is especially IMPORTANT for PTFE gaskets.

TIGHTENING METHOD USED:

____ Hand Wrench ____ Manual Torque Wrench ____ Hydraulic Torque Wrench

____ Impact Wrench ____ Other

* For questions, or large diameter flange tightening pattern, contact GRI Technical Services at (713) 467-1316, or tech@durlon.com

Worksheet Information by: _____ Date: _____

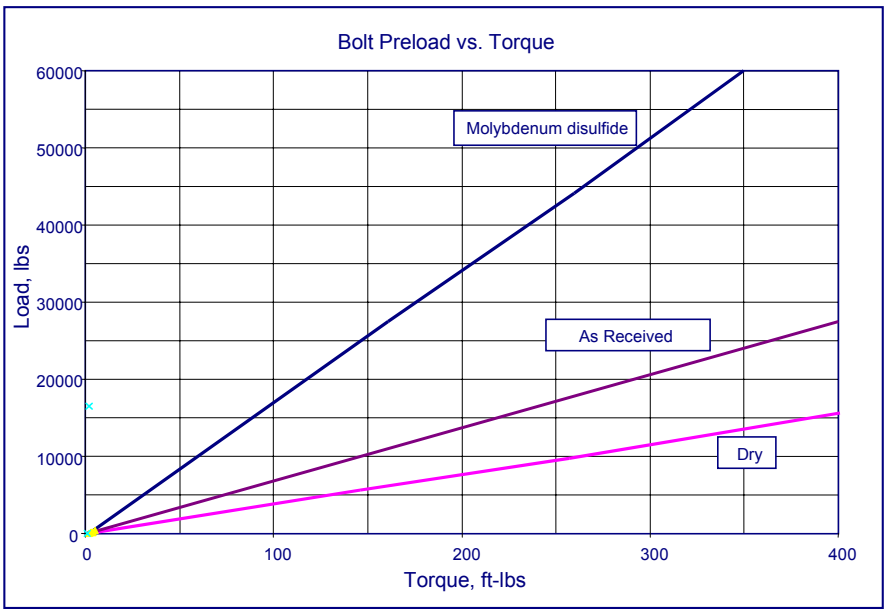
Joint Assembler: _____ Date: _____

THE EFFECT OF BOLT LUBRICATION

Bolt lubrication greatly affects the torque values used when installing gaskets. To achieve the same gasket compression, a much higher torque value is required for a dry bolt versus using an effective lubricant such as molybdenum disulfide.

In a dry bolt up, or where an inefficient lubricant is used, the effort used in tightening is overcome by the frictional forces between the bolts and nuts and to a greater extent between the nuts and nut facings.

This can result in a lower gasket load and inadequate stress on the bolts, which can result in torque loss and eventual leakage in service.



TORQUE VALUES – ASME B16.5 RAISED FACE FLANGES

ANSI B16.21 - RING GASKETS

1/16” & 1/8” DURLON® Gasket Material - Torque: ft-lbs

Flange Size	Class 150 RF						Class 300 RF						
	Min. Torque @ Pressure, psig				Max	# Bolts &	Min. Torque @ Pressure, psig					Max	# Bolts &
	100	150	200	285	Torque	Diameter	100	200	300	500	740	Torque	Diameter
1/2"	5	6	7	8	16	4 @ 1/2”	5	7	8	9	11	16	4 @ 1/2”
3/4"	8	9	10	11	23	4 @ 1/2”	10	12	14	17	20	38	4 @ 5/8"
1"	10	12	13	15	30	4 @ 1/2”	13	16	18	22	26	36	4 @ 5/8"
1-1/4"	16	18	20	22	46	4 @ 1/2"	20	25	28	35	41	55	4 @ 5/8"
1-1/2"	21	24	26	30	56	4 @ 1/2"	31	39	45	55	65	92	4 @ 3/4"
2"	42	48	53	60	113	4 @ 5/8“	21	27	30	37	44	62	8 @ 5/8"
2-1/2"	49	56	62	70	113	4 @ 5/8“	30	37	43	53	63	87	8 @ 3/4"
3"	72	82	90	113	130	4 @ 5/8“	43	54	63	77	92	126	8 @ 3/4"
3-1/2"	40	46	51	58	113	8 @ 5/8“	48	61	71	88	104	141	8 @ 3/4"
4"	51	58	64	73	113	8 @ 5/8“	61	77	90	111	132	179	8 @ 3/4"
5"	76	87	96	111	202	8 @ 3/4“	76	96	114	142	170	202	8 @ 3/4"
6"	96	110	122	142	202	8 @ 3/4“	64	81	97	121	145	187	12 @ 3/4"
8"	130	150	169	200	236	8 @ 3/4“	101	132	157	198	240	297	12 @ 7/8"
10"	124	145	165	193	327	12 @ 7/8“	106	141	169	216	264	310	16 @ 1"
12"	164	195	220	259	327	12 @ 7/8“	158	213	255	327	400	464	16@1-1/8"
14"	206	245	278	327	492	12 @ 1”	139	188	226	291	358	405	20@1-1/8"
16"	197	234	266	313	492	16 @ 1”	197	266	321	413	508	570	20@1-1/4"
18"	298	354	402	473	731	16@1-1/8"	221	298	359	461	566	644	24@1-1/4"
20"	266	317	360	425	731	20@1-1/8"	246	333	403	520	642	710	24@1-1/4"
24"	386	461	525	622	1036	20@1-1/4"	386	525	637	828	1027	1100	24@1-1/2"

Note: It is assumed that new ASTM A193 Gr. B7 studs with 2H heavy hex nuts and hardened steel washers are used and studs, nuts and nut facings are lubricated with a never-seize paste using the installation and bolt tightening practices outlined above. Torque is based the higher of 40% of bolt yield, T3 or 4800 psi gasket stress up to either the maximum allowable material stress or a maximum bolt yield of 60%. The above was calculated using the proposed ASME Gasket Constants (ROTT Testing, Ecole Polytechnique) for each material.

* Based on 1/16" Durlon 8500. Minimum values for DURLON 8300, 9400 and 9600 may require higher loads. Minimum sealing requirements for other DURLON materials may be lower.

GRI/**DUR**LON® - Chemical Resistance Chart

The following information is a general guide only for the selection of a suitable gasket material as there are unlimited combinations of fluid, pressure and temperature conditions

A - Acceptable
C - Caution - Depends on Conditions
NS - Not Suitable

FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE				FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE			
	8300	8400	8500	8600	8700	9000	9200W	9400	9600		8300	8400	8500	8600	8700	9000	9200W	9400	9600
Acetic Acid, Glacial (100%)	C	C	C	C	C	A	A	A	A	Detergent Solutions	A	A	A	A	A	A	A	A	A
Acetic Acid, 37%	A	A	C	A	A	A	A	A	A	Diacetone Alcohol	NS	NS	NS	NS	NS	A	A	A	A
Acetic Anhydride	A	C	C	C	C	A	A	A	A	Dibenzyl Ether	NS	C	C	NS	NS	A	A	A	A
Acetone	C	C	C	C	C	A	A	A	A	Dibutylamine	C	C	C	NS	C	A	A	A	A
Acetylene	A	A	A	C	A	A	A	A	A	Diesel Fuel	A	A	A	C	C	A	A	A	A
Air	A	A	A	A	A	A	A	A	A	Dimethyl Acetamide	NS	C	NS	NS	NS	A	A	A	A
Alum	A	A	A	A	A	A	A	A	A	Dimethylformamide	NS	C	NS	NS	NS	A	A	A	A
Aluminum Acetate	A	A	A	A	A	A	A	A	A	Dioxane	NS	NS	NS	NS	NS	A	A	A	A
Amines	C	C	C	A	C	A	A	A	A	Dowtherm A, E	NS	C	C	NS	NS	A	A	A	A
Ammonia, Gas <150°F	A	A	A	NS	A	A	A	A	A	Epichlorohydrin	NS	NS	NS	NS	NS	A	A	A	A
Ammonia, Liquid<150°F	A	A	A	C	A	A	A	A	A	Ethane	A	A	A	C	C	A	A	A	A
Ammonium Bisulfite	A	A	A	C	A	A	A	A	A	Ethyl Acetate	C	C	C	C	NS	A	A	A	A
Ammonium Chloride	A	A	A	A	A	A	A	A	A	Ethyl Alcohol (Ethanol)	A	A	A	A	A	A	A	A	A
Ammonium Hydroxide	A	A	A	A	A	A	A	A	A	Ethylbenzene	NS	NS	NS	NS	NS	A	A	A	A
Amyl Chloride	A	NS	NS	C	NS	A	A	A	A	Ethylchloride	A	A	A	NS	NS	A	A	A	A
Aniline, Aniline Oil	NS	NS	NS	NS	NS	A	A	A	A	Ethylene	A	A	A	NS	C	A	A	A	A
Arsenic Acid	A	A	A	A	A	A	A	A	A	Ethylene Dichloride	NS	NS	NS	NS	NS	A	A	A	A
Aviation Fuels	A	A	A	C	C	A	A	A	A	Ethylene Glycol	A	A	A	A	A	A	A	A	A
Barium Chloride	A	A	A	A	A	A	A	A	A	Ethyl Ether	C	C	C	NS	C	A	A	A	A
Benzene (Benzol)	NS	NS	NS	NS	NS	A	A	A	A	Ethylene Oxide	NS	NS	NS	NS	NS	A	A	A	A
Benzoic Acid	NS	NS	NS	NS	NS	A	A	A	A	Fatty Acids	A	A	A	NS	C	A	A	A	A
Black Sulfate Liquor<350°F	NS	A	A	C	C	A	A	A	A	Ferric Chloride	A	A	A	A	A	A	A	A	A
Black Sulfate Liquor>350°F	NS	C	NS	NS	NS	A	A	A	A	Ferrous Chloride	A	A	A	A	A	A	A	A	A
Bleach Solutions	C	A	C	C	C	A	A	A	A	Fluorine (Gas, Liquid)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boiler Feed Water	A	A	A	A	A	A	A	A	A	Formaldehyde	A	C	A	C	C	A	A	A	A
Borax	A	A	A	A	A	A	A	A	A	Formic Acid	NS	NS	NS	C	A	A	A	A	A
Brine	A	A	A	A	A	A	A	A	A	Freon	See Refrigerants								
Butadiene	NS	NS	NS	NS	NS	A	A	A	A	Fuel Oil	A	A	A	C	C	A	A	A	A
Butane	A	A	A	NS	C	A	A	A	A	Gas – Natural	A	A	A	NS	A	A	A	A	A
Butyl Acetate	NS	C	NS	NS	NS	A	A	A	A	Gasoline	A	A	A	NS	NS	A	A	A	A
Butyl Alcohol (Butanol)	A	A	A	A	A	A	A	A	A	Glucose	A	A	A	A	A	A	A	A	A
Butyl Methacrylate	NS	NS	NS	NS	NS	A	A	A	A	Glycerin (Glycerol)	A	A	A	A	A	A	A	A	A
Butylene (Butene)	A	A	A	NS	C	A	A	A	A	Green Sulfate Liquor	C	C	C	NS	C	A	A	A	A
Butyric Acid	A	A	C	C	C	A	A	A	A	Heptane	A	A	A	NS	C	A	A	A	A
Calcium Carbonate	A	A	A	A	A	A	A	A	A	Hexane	A	A	A	NS	C	A	A	A	A
Calcium Chloride	A	A	A	A	A	A	A	A	A	Hydraulic Oil (mineral)	A	A	A	C	C	A	A	A	A
Calcium Hydroxide	A	A	A	A	A	A	A	A	A	Hydraulic Oil (phos. ester)	C	C	C	NS	NS	A	A	A	A
Calcium Hypochlorite	C	A	C	C	C	A	A	A	A	Hydrazine	C	C	C	C	C	A	A	A	A
Carbon Dioxide, wet	A	A	A	C	C	A	A	A	A	Hydrochloric Acid, 30%	NS	C	NS	NS	NS	A	A	A	A
Carbon Disulfide	NS	C	NS	NS	NS	A	A	A	A	Hydrochloric Acid, Conc	NS	C	NS	NS	NS	A	A	A	A
Carbon Tetrachloride	NS	C	C	NS	NS	A	A	A	A	Hydrofluoric Acid <150°F	NS	NS	NS	NS	NS	NS	A	A	A
Caustic Soda (NaOH)	NS	A	C	C	NS	A	A	A	A	Hydrofluoric Acid >150°F	NS	NS	NS	NS	NS	NS	NS	A	A
Chlorine, liquid (dry) *	NS	NS	NS	NS	NS	A	A	A	A	Hydrogen	A	A	A	A	A	A	A	A	A
Chlorine (wet) *	NS	C	NS	NS	NS	A	A	A	A	Hydrogen Chloride, (dry)	A	NS	NS	NS	NS	A	A	A	A
Chlorine Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	Hydrogen Peroxide, 10%	C	C	C	C	C	A	A	A	A
Chloroform	C	A	C	NS	NS	A	A	A	A	Hydrogen Sulfide (dry)	A	A	C	C	A	A	A	A	A
Chromic Acid	NS	NS	NS	NS	NS	A	A	NS	A	Hydrogen Sulfide, (wet)	C	C	C	NS	C	A	A	A	A
Citric Acid	A	A	A	A	A	A	A	A	A	Iodine	A	A	A	A	NS	A	A	A	A
Coal Gas	NS	NS	NS	A	C	A	A	A	A	Isooctane	A	A	A	NS	C	A	A	A	A
Copper Sulfate	A	A	A	A	A	A	A	A	A	Isopropyl Alcohol	A	A	A	A	A	A	A	A	A
Corn Oil	A	C	C	NS	C	A	A	A	A	Jet Fuel	A	A	A	NS	C	A	A	A	A
Cotton Seed Oil	A	A	A	NS	C	A	A	A	A	Kerosene	A	A	A	NS	C	A	A	A	A
Creosote (Coal Tar)	A	A	A	NS	NS	A	A	A	A	Lactic Acid	A	A	A	A	A	A	A	A	A
Cresol	C	A	C	NS	NS	A	A	A	A	Linseed Oil	A	A	A	NS	C	A	A	A	A
Crude Oil	A	A	A	NS	C	A	A	A	A	Lubricating Oil	A	A	A	NS	C	A	A	A	A
Cumene	NS	NS	NS	NS	C	A	A	A	A	Magnesium Chloride	A	A	A	A	A	A	A	A	A
Cyclohexane	A	A	C	NS	C	A	A	A	A	Maleic Acid	A	A	A	C	NS	A	A	A	A

** Durlon 9000 is listed in Pamphlet 95 of the Chlorine Institute, as an acceptable gasket material for dry chlorine (liquid & gas) service. Gaskets for chlorine or oxygen service should be cleaned before installation.*

GRI/**DUR**LON® - Chemical Resistance Chart

FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE				FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE			
	8300	8400	8500	8600	8700	9000	9200W	9400	9600		8300	8400	8500	8600	8700	9000	9200W	9400	9600
Mercury	A	A	A	A	A	A	A	A	A	Refrigerant 402b	C	C	C	NS	A	A	A	A	A
Methane	A	A	A	NS	C	A	A	A	A	Refrigerant Blend 404a***	A	A	A	NS	A	A	A	A	A
Methyl Alcohol (Methanol)	A	A	A	A	A	A	A	A	A	Sea Water	A	A	A	A	A	A	A	A	A
Methylene Chloride	NS	NS	NS	NS	NS	A	A	A	A	Silver Nitrate	C	A	C	C	C	A	A	A	A
Methyl Ethyl Ketone	C	C	C	NS	C	A	A	A	A	Soap Solutions	A	A	A	A	A	A	A	C	A
Mineral Oil	A	A	A	NS	C	A	A	A	A	Sodium Bisulfite	A	A	A	A	A	A	A	A	A
Muriatic Acid	NS	C	NS	NS	NS	A	A	A	A	Sodium Carbonate	A	A	A	A	A	A	A	A	A
Naphtha	A	A	A	C	NS	A	A	A	A	Sodium Chloride	A	A	A	A	A	A	A	A	A
Natural Gas	A	A	A	NS	A	A	A	A	A	Sodium Hydroxide	C	A	C	C	NS	A	A	A	A
Nickel Sulfate	A	A	A	A	A	A	A	A	A	Sodium Hypochlorite	NS	NS	NS	C	C	A	A	C	A
Nitric Acid, <30%	NS	NS	NS	NS	NS	A	A	NS	A	Sodium Nitrate	A	A	A	C	C	A	A	A	A
Nitrogen	A	A	A	A	A	A	A	A	A	Sodium Silicate	A	A	A	A	A	A	A	A	A
Nitrogen Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	Sodium Sulfate	A	A	A	A	A	A	A	A	A
Nitrogen Tetroxide	NS	NS	NS	NS	NS	A	A	NS	A	Sour Crude Oil	A	A	A	NS	C	A	A	A	A
Octane	A	A	A	NS	C	A	A	A	A	Steam (to 450°F)	A	A	A	A	A	A	A	A	A
Oil, Crude	A	A	A	NS	C	A	A	A	A	Steam (over 450°F)	A	A	A	C	C	NS	NS	NS	A
Oil, Mineral	A	A	A	NS	C	A	A	A	A	Stearic Acid	A	A	A	C	A	A	A	A	A
Oleum (H2SO4)	NS	NS	NS	NS	NS	A	NS	NS	A	Stoddard Solvent	A	A	A	NS	C	A	A	A	A
Oxalic Acid	A	A	C	NS	C	A	A	A	A	Styrene	C	C	C	NS	NS	A	A	A	A
Oxygen, gas, liquid	NS	NS	NS	NS	NS	A	A	A	A	Sulfite Liquors	C	A	C	C	C	A	A	A	A
Pentane	A	A	A	NS	C	A	A	A	A	Sulfur (molten)	C	C	C	NS	C	A	A	A	A
Perchloroethylene	C	A	C	NS	NS	A	A	A	A	Sulfur Dioxide	NS	C	NS	NS	NS	A	A	A	A
Petroleum	A	A	A	NS	C	A	A	A	A	Sulfuric Acid, 20%	NS	NS	NS	NS	NS	A	A	A	A
Phenol	NS	NS	NS	NS	NS	A	A	A	A	Sulfuric Acid, Conc.	NS	NS	NS	NS	NS	A	C	A	A
Phosphoric Acid, 45%	C	C	C	NS	C	A	A	A	A	Sulfuric Acid, Conc>200°F	NS	NS	NS	NS	NS	A	NS	NS	A
Potassium Chloride	A	A	A	A	A	A	A	A	A	Sulfuric Acid, Fuming	NS	NS	NS	NS	NS	A	NS	NS	A
Potassium Hydroxide	C	A	A	C	C	A	A	A	A	SUVA	See Refrigerants								
Potassium Nitrate	C	C	C	C	C	A	A	C	A	Tar	A	A	A	C	C	A	A	A	A
Propane	A	A	A	NS	C	A	A	A	A	Tetrachloroethane	C	C	C	NS	NS	A	A	A	A
Propylene	NS	NS	NS	NS	NS	A	A	A	A	Tetrahydrofuran (THF)	NS	NS	NS	NS	NS	A	A	A	A
Pydrauls, Skydrols	C	C	C	NS	NS	A	A	A	A	Toluene	NS	NS	NS	NS	C	A	A	A	A
Pyridine	NS	NS	NS	NS	NS	A	A	A	A	Transformer Oil	A	A	A	NS	C	A	A	A	A
Red Sulfite Liquor	NS	C	NS	NS	NS	A	A	A	A	Transmission Fluid	A	A	A	NS	C	A	A	A	A
Red Sulfite Liquor > 200°F	NS	NS	NS	NS	NS	A	A	A	A	Trichloroethylene	C	C	C	NS	NS	A	A	A	A
Red Sulfite Liquor > 380°F	NS	NS	NS	NS	NS	C	C	C	A	Triethanolamine	C	C	C	C	A	A	A	A	A
Refrigerant R-11 **	A	A	A	NS	NS	A	A	A	A	Turpentine	A	A	A	NS	C	A	A	A	A
Refrigerant R-12 **	A	A	A	C	A	A	A	A	A	Urea	A	A	A	A	A	A	A	A	A
Refrigerant R-22 **	C	C	C	C	A	A	A	A	A	Varsol	A	A	A	NS	NS	A	A	A	A
Refrigerant R-113 **	A	A	A	C	A	A	A	A	A	Vegetable Oil	A	A	A	NS	C	A	A	A	A
Refrigerant HCFC 123 **	NS	C	C	NS	C	A	A	A	A	Vinegar	A	A	A	C	A	A	A	A	A
Refrigerant HCFC 124 ***	NS	C	C	NS	A	A	A	A	A	Vinyl Acetate	C	C	C	NS	C	A	A	A	A
Refrigerant HFC 125 ***	C	C	C	NS	A	A	A	A	A	Vinyl Chloride	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant HFC 134a ***	A	A	A	C	A	A	A	A	A	Water	A	A	A	A	A	A	A	A	A
Refrigerant HCFC 141b	A	A	A	NS	A	A	A	A	A	White Sulfate Liquor	A	A	A	A	A	A	A	A	A
Refrigerant HFC 236fa	A	A	A	NS	A	A	A	A	A	White Spirit	A	A	A	C	C	A	A	A	A
Refrigerant Blend H 62***	A	A	A	NS	A	A	A	A	A	Xylene	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant Blend HP80	C	C	C	NS	A	A	A	A	A	Zinc Chloride	A	A	A	A	A	A	A	A	A
Refrigerant 402a	C	C	C	NS	A	A	A	A	A	Zinc Nitrate	C	C	C	C	C	A	A	C	A
Refrigerant Blend HP81	C	C	C	NS	A	A	A	A	A	Zinc Sulfate	A	A	A	A	A	A	A	A	A

*** With Mineral Oil,* *** With Polyol Ester Oil*

Gaskets for chlorine or oxygen service should be cleaned before installation.

This information is a general guide for the selection of a suitable gasket material. The substances listed above are evaluated for their effect on the gasket materials at ambient temperature (-40°F to 100°F, or -40ºC to 38ºC) unless stated otherwise. For unusual conditions of fluid concentrates, internal pressures or temperature consult your representative. This evaluation is based on laboratory or field tests, or experience; however, no guarantee can be given as to the actual performance experienced by the end user.

There are several fluids used in food which can be sealed by SBR, however due to flavor pickup, we have used “C” caution on these products.

This Chemical Resistance Chart supersedes and obsoletes all previously issued charts.

Please go to our website for recommendations on **CFG**, **FGS95**, **FGL316**, **FGT316**, and additional chemical listings.

www.gasketresources.com

GRI/**DUR**LON® - Useful Conversion Factors

Abbreviations

SI	- International Metric Standard	in	- inch
km	- kilometer	ft	- foot
m	- meter	yd	- yard
cm	- centimeter	oz	- ounce
mm	- millimeter	lb	- pound
N	- Newton	L	- liter
MPa	- MegaPascal	Pa	- Pascal
kgf	- kilogram force	g	- gram

Multiples and sub-multiples of SI units

Factor by which the unit is multiplied		Prefix	Symbol
1,000,000	10^6	mega	M
1,000	10^3	kilo	k
100	10^2	hecto	h
10	10^1	deca	da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000,001	10^{-6}	micro	μ

Conversion Factors

A	B	To convert A to B multiply A by	To convert B to A multiply B by
Length			
cm	in	0.3937	2.54
mm	in	0.0394	25.40
m	ft	3.2808	0.3048
in	mils	1000	0.001
Force			
N	lbf	0.22482	4.4482
N	kgf	0.102	9.807
Weight			
kg	lb	2.2046	0.453593
g	oz	0.0352	28.3495
Stress or Pressure			
MPa	psi	145.034	0.006895
MPa	kPa	1000	0.001
N/mm^2	MPa	1	1
bar	psig	14.504	0.06895
bar	MPa	0.1	10
in. mercury	psig	0.4912	2.035
Torque			
g-cm	in-lb	1150	0.00069
N-m	ft-lb	0.738	1.36
Density			
g/cm^3	lbs/ft^3	62.4278	0.016
Volume/Flow			
L	cm^3	1000	0.001
mL	cm^3	1	1
ppm (by mass)	mg/kg	1	1
Temperature			
°C	°F	1.8 before adding 32	0.5556 after subtracting 32